Systematic Review

Derotational high tibial osteotomy in cases of anterior knee pain and/or patellofemoral instability: a systematic review

Bárbara Ferreira, Eluana Gomes, Inês Figueiredo, Ricardo Ribeiro, Cristina Valente, Diego Delgado, Mikel Sánchez, Renato Andrade, João Espregueira-Mendes

ARTICLE INFO

Keywords:
Derotational osteotomy
Patellofemoral instability
Knee Malalignment
Anterior knee pain
Tibia

ABSTRACT

Importance: Derotational high tibial osteotomy (HTO) is a surgical intervention for correcting rotational malalignments in the lower limb, which may contribute to anterior knee pain (AKP) and/or patellofemoral instability (PFI). This surgical technique is not yet widely implemented and requires a systematic evaluation of its outcomes.

Aim: To assess the effectiveness of derotational HTO in correcting rotational malalignments of the lower limb in patients with AKP and/or PFI through radiological, clinical, and patient-reported outcome measures.

Evidence review: Searches were conducted in the PubMed, Embase, and Web of Science databases up to March 3, 2023, to identify studies utilizing derotational HTO in patients with AKP and/or PFI. The primary outcome measures of interest were measurements of lower limb angular correction. Other radiological, clinical, and patient-reported outcome measures were also analyzed. The risk of bias was judged with the RoBANS tool.

Findings: A total of 8 studies were included, comprising 215 patients (27.0 ± 3.9 years) and 245 knees. The most reported angle was tibial torsion (k = 6 studies, n = 173 knees), with a mean difference between postoperative and preoperative values (postsurgical correction) ranging from −37.8° to −10.8°. Patient-reported outcome measures showed significant improvements in the postoperative moment, exceeding the minimal clinically important difference in almost all cases, and with high patient satisfaction (93.6%).

Conclusions and relevance: Derotational HTO allows the correction of rotational malalignments of the lower limb (tibial torsion) and promotes patient satisfaction.

Level of evidence: Level IV.

What is already known

- Lower limb malalignments have been identified as a contributing factor to PFI and AKP.
- Derotational HTO can be implemented to correct excessive tibial rotation in patients with lower-limb rotational malalignments.

* Corresponding author. Clínica Espregueira - Dragão, Entrada Nascente, piso-3, 4350-415, Porto, Portugal. Tel.: + 351 220 100 100.
E-mail address: espregueira@dhresearchcentre.com (J. Espregueira-Mendes).

https://doi.org/10.1016/j.jisako.2024.02.015
Received 18 December 2023; Received in revised form 9 February 2024; Accepted 25 February 2024
Available online 29 February 2024
2059-7754/© 2024 The Authors. Published by Elsevier Inc. on behalf of International Society of Arthroscopy, Knee Surgery and Orthopedic Sports Medicine. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).
What are the new findings

- Derotational HTO corrects lower limb rotational malalignments due to excessive tibial torsion.
- Derotational HTO, with or without concomitant surgical procedures, resulted in significant improvements in the clinical and functional scores, surpassing the minimal clinically important difference.

INTRODUCTION

Patellofemoral instability (PFI) and anterior knee pain (AKP) are multifactorial conditions that result from an interplay of multiple risk factors, including anatomical abnormalities, soft tissue deficiencies, and joint malalignment [1–8]. While anatomical and soft tissue insufficiencies are commonly corrected, lower limb rotational malalignments are often left unnoticed in this population.

Excessive external tibial torsion, femoral antetorsion, and varus or valgus may jeopardize the patellofemoral joint function, with an emphasis on rotational imbalance [9,10]. Deformity in the tibial alignment of the tibia leads to stress on the components of the joint, such as ligaments and cartilage, which can result in recurrent patellar subluxation and contribute to patellar maltracking and subsequently to AKP [11]. Indeed, AKP due to excessive external tibial torsion is still a rare condition that is diagnosed clinically [12]. Knees with AKP display increased tibial external rotation [13], and Teige [14] has argued the excessive rotation may generate medial patellofemoral ligament (MPFL) traction, causing medial pain. In most cases, the AKP in the patient with tibial torsional abnormalities is combined with patellar maltracking and PFI [15–19], but can also appear as isolated without PFI [12]. Only a few studies have investigated lower limb malalignment as a predisposing factor for AKP, and this can lead to an underdiagnosed problem and an unsuccessful treatment [20].

The surgical treatment of lower limb rotational malalignments has been mostly overlooked by the scientific community. Already in 1995, Flandry and Hughston [21] reported that some of the surgeries that aimed the realignment of the extensor mechanism failed because the torsional irregularity was left untreated. Indeed, Stevens et al. [22] have later shown clinical improvements of torsional femoral/tibial osteotomies in patients after a previously failed surgery for PFI or AKP. Lower limb rotational malalignment can be treated by derotational osteotomy, aiming to correct lower limb and patellofemoral alignment while lowering the pressure of patellofemoral joint and mitigate AKP [10,23]. If the problem is an excessive external tibial torsion greater than 30° that is associated with clinical symptoms, then a derotational high tibial osteotomy (HTO) is indicated. However, there is still no consensus on the impact of derotational HTO in treating PFI and AKP, nor have the results been adequately systematized in the literature. Therefore, the aim of this systematic review was to summarize the imaging and clinical results of derotational HTO to correct lower limb rotational malalignments in patients with AKP and/or PFI.

METHODS

This systematic review was designed and conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement [24] and following the recommendations of the PRISMA-PERSiST consensus [25]. The protocol was a priori registered in the PROSPERO database under the number CRD42023397736.
those from the studies included in this systematic review, were manually screened to search for any additional eligible studies.

Study selection

All studies resulting from the database search were exported to "Mendeley Desktop,” where duplicated studies were automatically removed and subsequently confirmed through manual verification. Two authors (B.F. and R.A.) independently examined all titles and abstracts found to identify potentially relevant studies for inclusion. After this initial screening, relevant studies were read in full to assess whether they met the preestablished eligibility criteria (substantial agreement, $\kappa = 0.773, p < 0.001$).

Data collection and extraction

All data collected from the included studies and the results obtained from each were extracted and compiled by two authors (B.F. and R.A.), including: study and population characteristics (first author, year, region, number of patients, age, sex, body mass index [BMI], knee laterality, and condition/diagnosis); surgical procedure characteristics (type of procedure, previous surgeries/conservative treatments, and follow-up time); and pre- and post-surgical outcomes (angles, clinical and patient-reported scores, and satisfaction).

Data management

Data were collected as mean and standard deviation (SD) for continuous outcomes and frequency and percentage (%) for categorical data. When mean and SD were not available, it was sought to calculate these (when feasible) using the methods recommended by the Cochrane Handbook [26]; otherwise, other metrics of central tendency and dispersion (such as median, interquartile range [IQR], and 95% confidence intervals [CI], among others) were collected.

For the assessment of satisfaction, the terms “satisfied” “very satisfied” and “be happy with the results” were considered.

Data synthesis

Data were summarized as mean and SD for continuous outcomes and frequency and percentage (%) for categorical data. All summary measures were computed as weighted by the sample size. When only the median was available, two formulas were used to estimate the mean and SD [27]. When the sample size was equal to or lower than 25, then the median was used instead of the imputed mean value.

Outcomes were reported as the data at baseline and follow-up. The within-group mean difference (MD), when not reported by the original study, it was calculated for each outcome (with their SD and 95% CI) of each study that provided data both at baseline and follow-up. The SD of pre-to-post MD was calculated using a correlation coefficient of 0.5. The within-group P value of pre-to-post changes was also extracted and reported. When the P value was not reported but the within-group MD was calculated, the significance was assessed by examining the pre-to-post MD (whether it included zero or not). If it did not include zero, it was assumed to be significant. The effect size (Cohen’s d) between pre-to-post was calculated for each outcome (when feasible). The Cohen’s d can be interpreted as large ($ \geq 0.8$), moderate ($0.5-0.79$), or weak ($0.2-0.49$) [28].

When available, the percentage of improvement (MD) was computed as compared to the minimally clinically important difference (MCID). The MCID reference value was determined using cut-off data from previously published studies for each specific patient reported outcome measures (PROMs): Lysholm (MCID = 11.1 points) [29]; Kujala (MCID = 9.1 points) [29]; Knee injury and Osteoarthritis Outcome Score (KOOS; MCID = 9.0 points for “pain,” 10.8 points for “symptoms,” 10.0 points for “activities of daily living,” 17.8 points for “sports and recreation,” and 12.7 points for “quality of life” points) [29]; short-form health survey 36-item (SF-36 Score; MCID = 3.9 points for “physical functioning,” 4.0 points for “role limitations due to physical health,” 1.7 points for “role limitations due to emotional problems,” 2.9 points for “energy/fatigue,” 4.4 points for “emotional well-being,” 7.3 points for “social functioning,” 6.4 points for “pain,” and 5.3 points for “general health”) [30].

Risk of bias

The risk of bias was judged using the Risk of Bias Assessment tool for Non-randomized Studies (RoBANS) [34]. This tool includes six domains of bias: “selection of participants,” “confounding variables,” “exposure measurement,” “blinding of outcome assessment,” “incomplete outcome data,” and “selective outcome reporting.” The risk of bias was judged at the outcome level (i.e. divided for imaging/clinical measurements and PROMS) for the “exposure measurement” domain. Two authors (B.F. and R.A.) assessed the risk of bias of all included studies, and if disagreements were deliberated until a consensus was reached (almost perfect agreement, $\kappa = 0.957, p < 0.001$). Each domain was judged as “low risk,” “high risk,” or unclear according to predefined criteria (Supplement 2).

RESULTS

Research results and characteristics of the studies

After searching the databases and conducting manual searches, 3061 records were obtained, and 69 full studies were read to assess their eligibility criteria and compliance. This process led to the inclusion of eight eligible studies in this systematic review [12,15–19,35,36] (Fig. 1).

Risk of bias

All the studies had a high risk of bias in at least one domain, with approximately 50% of studies having four or more domains judged as high risk (Fig. 2).

A high risk of selection bias was judged in 75% of studies due to “selection of participants” as the inclusion of individuals with APK and PFI in the same sample. High risk of selection bias due to “confounding variables” was judged as high risk in all studies because all studies included concomitant and/or previous interventions. More than a half (75%) of the studies displayed a high risk of performance bias in the “imaging/clinical outcomes” domain due to a lack of postoperative reported measures and/or a lack of validated instruments for the measurements. One study [19] (13%) was judged to have an unclear risk of performance bias in the “imaging/clinical outcomes” domain due to a report of time to follow-up, which makes it impossible to assess if the evaluation timepoints were long enough. In the “PROMS” outcome, one study [12] (13%) was judged as high-risk due to using validated methods for some outcomes. All studies showed a high risk of detection bias due to the lack of blinding of outcome assessors. Attrition bias was present in two studies (25%) due to missing data superior to 5% of the outcome variable. Conversely, no study was judged to have a high risk of reporting bias.

Characteristics of the population

A total of 215 patients (245 knees) with a mean age of 27.0 ± 3.9 years were included for analysis (Supplement 3). The majority of
participants included were women (n = 173, 80%). All included studies (except two [17,35]) comprised patients with AKP and PFI (either concomitantly or patients with any of those). The remaining two studies reported only patients with AKP [17], and the other only reported PFI [35].

Surgical procedure characteristics

All surgical procedures are based on a derotational HTO. The majority of studies fixed the osteotomy with one or more staples, with one study [35] combining the staple fixation with a plate, two studies [12,17] fixed with a plate, and one study [12] using screws with or without a plate. Concomitant surgeries were performed in the majority of patients, with the most common being the reconstruction of the MPFL [16,19] and the lateral retinaculum release [16,17]. Other procedures were also performed only in specific cases and are reported in Supplement 4.

Many of the cases undergoing osteotomies had undergone prior treatments, both surgical and conservative (Supplement 4). Conservative treatments are mentioned in three studies [15,16,17] and the lateral retinaculum release [16,17]. Other procedures were also performed only in specific cases and are reported in Supplement 4.

Many of the cases undergoing osteotomies had undergone prior treatments, both surgical and conservative (Supplement 4). Conservative treatments are mentioned in three studies [15,16,17] and the lateral retinaculum release [16,17]. Other procedures were also performed only in specific cases and are reported in Supplement 4.

Impact of derotational high tibial osteotomy on angles and scores

Imaging and clinical measurements (angles and distances)

The most frequently measured outcomes of lower limb rotation were tibial torsion angle (k = 7) and femoral antetorsion angle (k = 3). Other rotation and lower-limb alignment measurements included the knee-joint rotation, femoro-tibial angle, thigh-foot angle, hip-knee-ankle angle, and the quadriceps angle. For other measurements of the patellofemoral joint, the most common were the tibial tuberosity to trochlear groove (TT-TG) distance (k = 4) and the Caton–Deschamps index (k = 4).

Tibial torsion angle was reported in seven studies [12,15–19,35], however, in one of them [17], it was not possible to ascertain the MD as it was not reported the postoperative value (Table 1). The remaining six, with an average follow-up duration ranging from 25 to 84 months, had a pre-to-post MD ranging from −37.8° to −10.8°, all with significant improvements (effect size ranging from 2.8 to 10.3). Femoral antetorsion angle was reported in three studies [12,17,18] with a mean follow-up period ranging between 51.6 and 66 months. While one study [18] reported a median improvement of 2.9 that was not statistically significant, the other studies [12,17] only reported the baseline preoperative value (Supplement 5).

All other measurements were heterogeneously reported and thus are not summarized and are only reported for each study in Supplement 5.

Clinical and functional patient reported outcome measures

The Kujala score was the most frequently PROMS reported [17,35,36]. The follow-up period ranged from 15 to 157 months, with a total of 87 knees from 84 patients evaluated. There was a statistically significant improvement (pre-to-post MD) ranging between 30 and 55.5 points (effect size from 1.7 to 4.0). The improvements were two- to five-fold higher than the MCID (Table 2).

The Lysholm, KSS, and VAS scores were the other three common PROMs reported in at least two studies (Table 2). The Lysholm score (53 cases with average follow-up ranging from 25 to 42 months) was mentioned in two studies [15,16] and improved statistically significantly between 26 and 30 points (effect size from 1.2 to 2.1) with a MCID around 250%. The KSS score (51 cases with average follow-up ranging from 55 to 84 months) was reported in two studies [12,35] with both the KSS clinical and function sub-scores showing statistically significant improvements. The pre-to-post MD was 38 and 51.7 points (effect size from 2.8 to 4.1) for the clinical sub-score, and 25 and 59.4 points (effect size from 1.6 to 2.8) for the functional sub-score. These improvements ranged between 257% and 718% of the MCID. The VAS (49 cases with an
average follow-up of 42 and 84 months) was reported in two studies [16, 35] and showed a statistically significant improvement of −6.4 and −3.4 (effect size from 1.4 to 3.7), with 138%–260% of the MCID.

The remaining clinical and functional PROMs (ROOS, SF-36, SF-12, Lille, WOMAC, Tegner, Japanese Knee Society, and Fulkerson) were reported only in a single study (Supplement 6). These scores globally showed a statistically significant pre-to-post improvement with a percentage of MCID of at least 180% and up to 1980%. Only the Tegner score [16] showed an improvement that did not achieve the cut-off of the MCID (despite the improvement being statistically significant).
Table 2
Clinical outcomes assessed before and after surgery.

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Follow-up</th>
<th>Baseline</th>
<th>Postoperation</th>
<th>MD ± SD (95% CI)</th>
<th>Within-group p value</th>
<th>MCID (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kujala score (0–100 pt)</td>
<td>36–48</td>
<td>50 ± 23</td>
<td>80 ± 10</td>
<td>30 ± 19.97 (18.7–41.3)</td>
<td>p &lt; 0.001</td>
<td>330%</td>
</tr>
<tr>
<td>Drexler et al. (2014) [35]</td>
<td>84 (15–156)</td>
<td>31.3 ± 15.1</td>
<td>86.8 ± 12.5</td>
<td>55.5 ± 14 (48.4–62.6)</td>
<td>p = 0.002</td>
<td>610%</td>
</tr>
<tr>
<td>Manilov et al. (2020) [17]</td>
<td>66 (24–157)</td>
<td>47.5 ± 14.6</td>
<td>93.0 ± 8.9</td>
<td>45.5 ± 12.7 (42.3–48.7)</td>
<td>p &lt; 0.001</td>
<td>500%</td>
</tr>
<tr>
<td>Pain (0–35)</td>
<td>8.6 ± 5.8</td>
<td>30.4 ± 5.9</td>
<td>21.8 ± 5.9</td>
<td>11.5 ± 4.8 (10.3–12.7)</td>
<td>p &lt; 0.0001</td>
<td>–</td>
</tr>
<tr>
<td>Instability (0–20)</td>
<td>6.4 ± 5.4</td>
<td>17.9 ± 3.6</td>
<td>11.5 ± 4.8</td>
<td>10.3 ± 12.7</td>
<td>p &lt; 0.0001</td>
<td>–</td>
</tr>
<tr>
<td>Stair-climbing ability (0–20)</td>
<td>6.9 ± 5.6</td>
<td>17.9 ± 3.6</td>
<td>11 ± 4.9</td>
<td>9.8–12.2</td>
<td>p &lt; 0.001</td>
<td>–</td>
</tr>
<tr>
<td>Lysholm functional knee score (modified) (0–100 pt)</td>
<td>25 (12–38.4)</td>
<td>40 ± 22</td>
<td>70 ± 28</td>
<td>30 ± 25.5 (17.9–42.1)</td>
<td>NR</td>
<td>270%</td>
</tr>
<tr>
<td>Dickschas et al. (2017) [16]</td>
<td>42 (6–131)</td>
<td>66 ± 14.9</td>
<td>92 ± 9.3</td>
<td>26 ± 16.2 (22.1–29.9)</td>
<td>p = 0.001</td>
<td>234%</td>
</tr>
<tr>
<td>KSS clinical score (0–100 pt)</td>
<td>55 (12–174)</td>
<td>56 ± 14.8</td>
<td>94 ± 12.1</td>
<td>38 ± 13.7 (33.5–42.5)</td>
<td>p &lt; 0.001</td>
<td>528%</td>
</tr>
<tr>
<td>Foulieron et al. (2010) [12]</td>
<td>84 (15–156)</td>
<td>37.3 ± 14.2</td>
<td>89 ± 11</td>
<td>51.7 ± 12.9 (45.2–58.2)</td>
<td>p = 0.002</td>
<td>718%</td>
</tr>
<tr>
<td>Drexler et al. (2014) [35]</td>
<td>84 (15–156)</td>
<td>71 ± 18.4</td>
<td>96 ± 11.9</td>
<td>25 ± 16.2 (19.7–30.3)</td>
<td>p &lt; 0.001</td>
<td>257%</td>
</tr>
<tr>
<td>KSS function score (0–100 pt)</td>
<td>84 (15–156)</td>
<td>25.2 ± 26</td>
<td>84.6 ± 13.9</td>
<td>59.4 ± 22.5 (50.7–80.8)</td>
<td>p = 0.002</td>
<td>612%</td>
</tr>
<tr>
<td>Visual Analog Scale (0–10)</td>
<td>84 (15–156)</td>
<td>8.8 ± 1.9</td>
<td>2.4 ± 1.5</td>
<td>–6.4 ± 1.7 (–7.3 to –5.5)</td>
<td>p = 0.002</td>
<td>260%</td>
</tr>
<tr>
<td>Dickschas et al. (2017) [16]</td>
<td>42 (6–131)</td>
<td>5.7 ± 2.8</td>
<td>2.3 ± 1.8²</td>
<td>–3.4 ± 2.9 (–4.1 to –2.7)</td>
<td>p = 0.001</td>
<td>138%</td>
</tr>
</tbody>
</table>

MD: mean difference; SD: standard deviation; CI: confidence interval; MCID: minimal clinically important difference; KSS: Knee Society Score; NR: not reported.

*Only included 89.7% of the patients. The loss of follow-up was 5 of 49 patients.

Patient satisfaction

Patient satisfaction was reported in four studies (78 patients) [12,18,35,36] and the average number of patients who would undergo the procedure again was reported in three studies [16,35,36]. The average weighted satisfaction rate was 93.6% (Fig. 3A) and the average weighted percentage of patients who would consider undergoing the surgery again was 86.4% (Fig. 3B).

Complications

Complications were reported in seven studies [12,15–18,35,36]. The overall rate of complications was 13.8% (31/224 knees). The most common complications included pain or irritation at the osteotomy site or nervous-related symptoms of the peroneal nerve (Supplement 7). More serious complications included a case of permanent palsy of the extensor hallucis longus [17] and two cases of collapse at the tibial osteotomy site with subsequent varus malalignment; one was resolved with a structural allograft and lateral plate, but the other required conversion to total knee arthroplasty [35]. There were no cases reported of patellar re-dislocation.

DISCUSSION

The most important finding of this systematic review is that derotational HTO is able to correct lower limb rotational malalignments in patients with AKP and/or PFI as measured by tibial torsion. The derotational HTO can also result in a statistically significant improvement in PROMs with a high patient satisfaction rate. Despite the favorable outcomes, the studies exhibited a high risk of bias in most domains (selection, performance, and detection bias), which may have underestimated or overestimated results. Furthermore, due to the multifactorial nature of AKP and PFI, it is often necessary to address various anatomical risk factors simultaneously, which may also have contributed to the improvements observed in PROMs and patient satisfaction.

These results are in line with those from a previous systematic review [37] that also summarized results from derotational HTO. However, this previous systematic review included studies that combined simultaneous tibial and femoral osteotomies, as well as studies involving osteotomies concomitantly with prosthetic components. This is an important confounding factor (selection bias) that hinders the discernment of the origin of these outcomes (if from the derotational HTO itself, if from the concomitant procedures, or from the combination of both). Moreover, it is important to highlight that the database search of the previous systematic review only included studies published starting from 2010 onwards, thus neglecting earlier studies without a valid justification (in the present systematic review, there were three [15,18,36] studies prior to 2010 that were relevant for the analysis).

Derotational HTO has been shown to be able to statistically significantly correct tibial torsion in patients with AKP and/or PFI. The correction of excessive tibial torsion (>30°) was associated with statistically significant clinical improvements [12,15–18,35]. At baseline, tibial torsion was over 30° in all studies that reported this measure [12,15–19,35] and showed a clear improvement that resulted in a tibial torsion below 30° in all but two studies [16,19]. However, although Dickschas et al. [16] showed a postoperative tibial torsion of around 36.5°, it was still associated with statistically significant clinical improvement. The PROMs exhibited a statistically significant improvement, not only statistically but also surpassing the MCID cut-off. Overall, irrespective of the magnitude of lower limb alignment correction, derotational HTO effectively reduces pain, instability, and joint-related symptoms and improves knee function and health-related quality of life. Indeed, the overall satisfaction rate was over 90%, and most patients reported that they would undergo the surgery again. Only the Tegner score did not achieve the MCID [16]; however, the postoperative Tegner score was 4.3. These results are aligned with those of the previous systematic review [37], which had shown improvements in anatomical correction and PROMs with high tibia derotational osteotomy in cases of patients with excessive external torsion associated with PFI.

Given that tibial torsional malalignments can contribute to AKP or PFI, it is important to evaluate tibial torsion and lower limb alignment in patients who report AKP and/or PFI. This evaluation helps identify those who may benefit from correcting malalignment deformities. Since the cut-off value of tibial torsion to perform derotational HTO is not defined, this systematic review suggests correcting tibial torsion to below the cut-off of 30° or lower [21,38,39] and because it has demonstrated an improvement in the clinical and measurement outcomes of the included studies [12,35].

In cases where there are malalignment deformities, a derotational osteotomy should be considered as an isolated procedure or combined with other surgeries if there are other underlying risk factors. Some caution should be considered when performing isolated TTT when there are excessive tibial torsional malalignments because it may increase contact pressure at the medial knee compartment and change the knee contact pressure at the medial knee compartment.
force distribution, contributing to early knee degenerative changes \[38, 40\]. In fact, when comparing derotational HTO combined with proximal realignment against the traditional proximal-distal realignment (Elmslie-Trillat-Fulkerson procedure) in patients with tibial torsional deformities, the derotational osteotomy resulted in a superior improvement \[36\]. Another study \[35\] reported positive outcomes when combining the TTT with derotational HTO to treat patella subluxation with excessive external tibial torsion (>45°). In some cases, MPFL augmentation may be needed; however, Dickschas et al. \[16\] concluded that derotational HTO was able to treat PFI and decrease pain intensity without the need for MPFL augmentation. Thereby, some of the additional procedures need to be reconsidered before subjecting patients to unnecessary procedures. Despite the advantages of derotational osteotomy, this surgery is not widely used to treat AKP and PFI. A TTT is the most common procedure to correct the extensor mechanism in cases of PFI. Nevertheless, recent research has indicated that performing only the TTT in patients with excessive external tibial torsion may increase medial tibiofemoral contact pressure and alter the distribution of forces within the joint, which contribute to the development of early knee osteoarthritis \[38, 40\]. In these cases where there is a genu varum associated, the TTT is contraindicated if the knee varus is not corrected with a valgization osteotomy (closed wedge) in addition to the derotational HTO. When combined with TTT, if the derotational osteotomy cut is performed above the tibial tubercle it will change the TT-TG, but not when the cut is performed below the tibial tubercle.

Double-level osteotomies are still a challenging procedure, and some authors recommend performing only one-level knee osteotomies, either at the distal femur or the proximal tibia \[41, 42\]. Fouilleron et al. \[12\] showed that having a femoral torsion above 20° did not negatively impact the clinical outcomes. Therefore, patients with two types of opposing excessive rotation (femoral antetorsion and tibial rotation) with AKP can be treated only with a derotational HTO. Manilov et al. \[17\]
corroborate this finding by reporting no differences in their outcomes in patients with or without excessive femoral antetorsion. When femoral antetorsion is concomitantly present with increased tibial torsion and does not exceed 25° of antetorsion, they suggest performing a derotational HTO as the first option of treatment and postpone the femoral rotational malalignment to subsequent surgeries, if necessary.

While derotational HTO displayed good outcomes related to correcting malalignments, PROMs, and satisfaction, the persistently challenging issue lies in the complications, encompassing peroneal nerve injury, knee stiffness, and irritation or pain over the osteotomy site. Most cases of peroneal nerve injury resolved spontaneously after some time following the surgery (up to 6 months), but there was one case of permanent palsy of the extensor hallucis longus. Some serious complications can emerge, with some cases requiring surgical intervention due to collapse at the tibial osteotomy site with subsequent varus malalignment [35], poor bone healing [16], painful fibular pseudarthrosis [16], and compartment syndrome [16]. We highlight the case of collapse at the tibial osteotomy site with subsequent varus malalignment [35] that required conversion to total knee arthroplasty 6 months after the derotational HTO.

There are some limitations to be acknowledged, some related to our review and others inherent to the included studies. It is important to note that many studies were excluded because they mixed both high tibial and distal femur derotational osteotomies [22,23,43,44]. However, despite being excluded toeschew bias from our results, their results were in conformity with those summarized in this systematic review. The small number of patients in each study and the heterogeneity of the reported outcomes across the included studies were also major limitations of this systematic review. The lack of comparative studies precluded the head-to-head comparison (meta-analysis) of the derotational osteotomy technique against other commonly performed surgeries in AKP and PFI. Likewise, the variability in the reported outcomes across the included studies precluded the performance of a pre-to-post meta-analysis due to heterogeneity concerns.

Another limitation arises from the fact that it was often performed in conjunction with previous or concomitant knee surgeries, making it difficult to ascertain the exact impact of the surgery under study in isolation. Indeed, patients with previous knee surgeries may represent more complex cases with symptoms that remain unresolved after failed previous treatments. Although the ideal approach to study this surgery would be to begin with a patient without prior or concomitant surgeries, this is not feasible in real clinical practice. Ignoring other underlying risk factors solely to obtain clearer results would not be practical and far from ethical.

The angle measurements were not uniformly obtained, resulting in data sourced from both imaging studies and physical examinations (such as with a goniometer). This heterogeneous method of measurement is likely to bias the angle measurement results. To account for this limitation, the studies with nonvalid measurements were judged to have a high risk of performance bias in the domain “measurement of exposure.”

Lastly, because derotational HTO is still not common, there are no specific MCIDs established for this surgery. Therefore, the MCIDs from similar surgeries (around the knee) were used instead, which could approximate the values but may not be ideal for the surgical procedure. The MCID for the WOMAC score is based on their traditional scoring system [35] that reported the WOMAC used a 0–100 scoring system for each of the WOMAC subscales, making it unreliable to compare their results against the MCID. Indeed, there are concerns across the literature about how the WOMAC is heterogeneously used and reported, leading to uncertainty in the interpretation of the results across studies [45].

CONCLUSION

The derotational HTO represents an effective intervention in the management of AKP and PFI with lower limb rotational malalignments, correcting excessive tibial malrotation. Studies also show improvements in clinical and functional PROMs with high patient satisfaction but should be perceived with caution due to the high rate of concomitant surgeries performed (common in these patients to correct other underlying risk factors), which may have contributed to the clinical and functional improvements.

Funding

None to declare.

Ethical approval

Non-applicable for this type of study.

Informed consent

Non-applicable for this type of study.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

None.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jisako.2024.02.015.

References


